Generating Contiguous Meshes for "Sloppy" Assembly Models

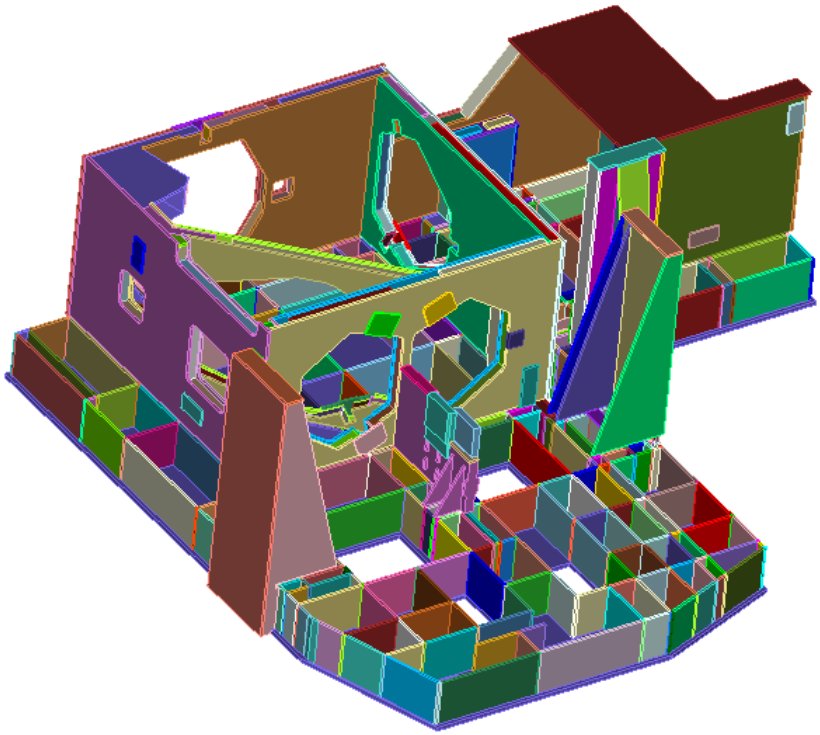

Figure 1: Example of CAD assembly model with hundreds of components.

Enhanced software speeds up analyses of complex weapons component assemblies

For more information:

Technical Contact:
Brett Clark
505-844-0434
bwclark@sandia.gov

Science Matters Contact:
Alan Burns
505-844-9642
aburns@sandia.gov

Sandia regularly performs structural and thermal analyses on large nuclear weapon assembly models containing hundreds of components (see Figure 1). Since these analyses frequently require a discretized version, or "mesh," of the model, there is a need for software tools that automatically generate meshes. This is not a trivial task and has for many years been one of the main bottlenecks in the analysis process. Through advances in computational modeling, Sandia now has capabilities that have greatly reduced the amount of time required to generate meshes for large assemblies.

Many large assemblies contain "slop," or significant gaps, overlaps, and misalignments between assembly components. Slop may arise in a design from poor modeling practices or a mismatch in modeling tolerances between the original CAD (computer automated design) system and the meshing tool reading the input. Sometimes the models are accurate, but details such as press fit tolerances and adhesive layers must be removed under certain analysis conditions.

Meshes of assembly models are generally required to be contiguous across component-component interfaces. This means that two components that are in contact with one another in an assembly will share a mesh at the surface(s) of contact. Generating a shared mesh generally requires the CAD model to share surfaces between contacting parts. However, CAD models typically do not use this representation (often referred to as a "non-manifold" representation), and so it is necessary for the mesh generation package to generate a shared topology between parts before meshing.

The automatic recognition and creation of non-manifold connections between neighboring weapons assembly components requires the use of proximity checks to determine which components should be touching. If there are large gaps or misalignments between components, it is very difficult to determine if the design intent is for two components to be touching or not. This ambiguity generally complicates the process for automation as well as for manual intervention.

Thus Sandia has developed tools for generating non-manifold representations of CAD assembly models. These powerful tools are particularly helpful in the cases where there is significant slop in the CAD model that would normally require hours of manual geometry modification to fix. As shown in

the flow diagram in Figure 2, improvements include tools to help the user identify the slop in the assembly, algorithms to automatically and tolerantly enforce criteria for creating non-manifold connections, and tools to analyze the results and identify remaining issues. For example, close proximities within the model now help determine the smallest allowable feature size. Then the largest allowable gap in the model is determined. Recent tests have shown an order of magnitude reduction in the number of manual geometric modifications required by the user when using these new tools. This equates to days saved in preparing a mesh for analysis.

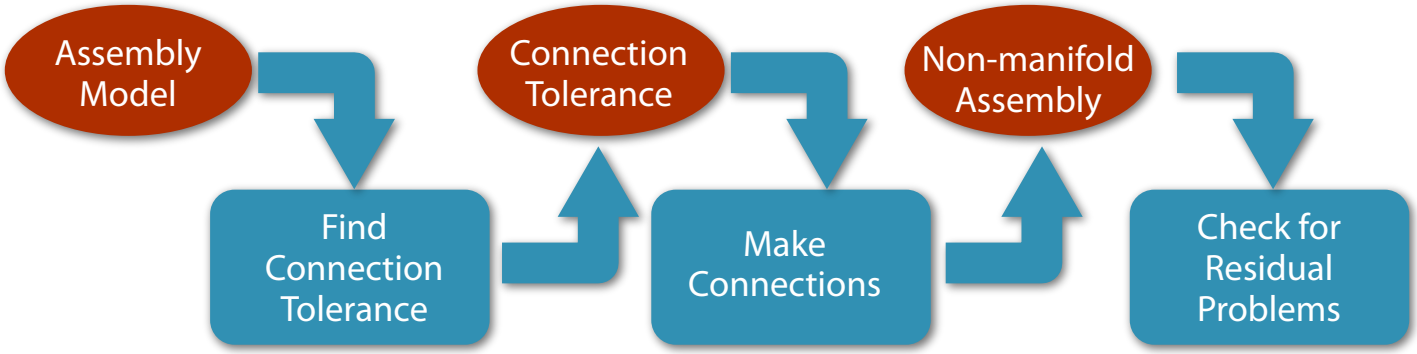

Figure 2: Flow diagram showing the process of generating connections in an assembly. The newly developed tools aid in the tasks highlighted by the blue boxes.

Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND2009-1131P

National Nuclear Security Administration

02/2009